CLAIMS

1. A hollow microparticle comprising a hollow portion and a high-density polymer brush layer enclosing the hollow portion.

2. The hollow microparticle according to Claim 1, wherein the density of chains composing the polymer brush layer is 0.4 to 1.2 chains/nm^2.

3. The hollow microparticle according to Claim 1, wherein the polymer chain composing the polymer brush layer is a block copolymer of at least one crosslinkable monomer having a crosslinkable functional group and a non-crosslinkable monomer,

blocks of the crosslinkable monomer are located innermost of the polymer brush layer, and

crosslinkable monomer blocks in a polymer chain and the crosslinkable monomer blocks in a discrete polymer chain are crosslinked via a linkage formed by reaction between the crosslinkable functional groups or via a linkage formed by reaction between the crosslinkable functional groups and a polyfunctional compound.

4. The hollow microparticle according to Claim 3, wherein the crosslinkable monomer is acrylic acid, methacrylic acid or an acrylate or methacrylate having a functional group selected from the group consisting of an epoxyalkylene group, an aminoalkylene group, an oxetanylalkylene group and a cinnamoylalkylene group, and

the non-crosslinkable monomer is selected from the group consisting of an acrylate derivative, a methacrylate derivative, a styrene derivative, vinyl acetate and acrylonitrile.

5. The hollow microparticle according to Claim 2, wherein the molecular weight distribution index of each block of the polymer chain is from 1 to 1.50.

6. The hollow microparticle according to Claim 3, wherein the degree of polymerization of the crosslinkable monomer block is from 10 to 10000, and the

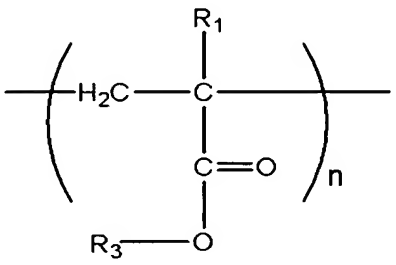
degree of polymerization of the non-crosslinkable monomer block is from 10 to 10000.

7. The hollow microparticle according to Claim 1, which has a particle size of from 60 nm to 5 μm.

8. A hollow microparticle comprising a hollow portion and a high-density polymer brush layer enclosing the hollow portion, wherein a polymer chain composing the polymer brush layer is a block copolymer of:

i) a crosslinkable monomer block located at inner part of the polymer brush layer, which is represented by the formula:

[Formula 53]

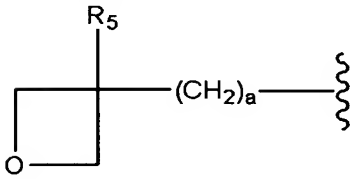


wherein

R_1 is a hydrogen atom or a C_1 to C_6 alkyl group,

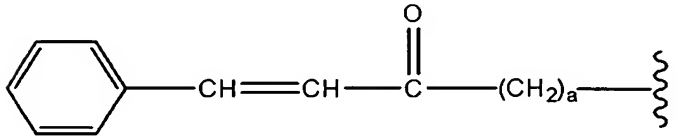
R_3 is a crosslinkable functional group represent by the formula:

[Formula 54]



or

[Formula 55]

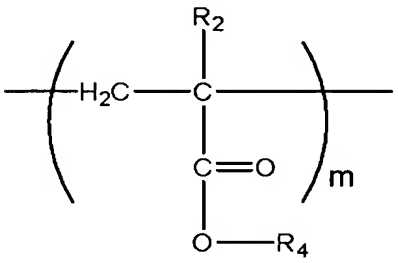


wherein R_5 is a hydrogen atom or a C_1 to C_6 alkyl group, and a is an integer of from 1 to 3, and

n is from 10 to 10000; and

ii) a non-crosslinkable monomer block located at outer part of the polymer brush layer, which is represented by the formula:

[Formula 56]



wherein

R_2 is a hydrogen atom or a C_1 to C_6 alkyl group,

R_4 is a hydrogen atom, a C_1 to C_{12} alkyl group or a phenyl group, and

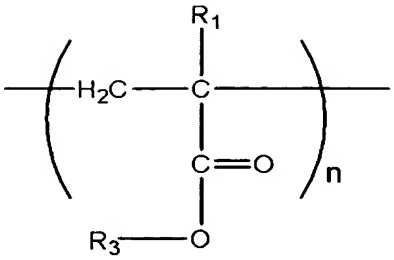
m is from 10 to 10000; and

wherein crosslinkable monomer blocks in a polymer chain and the crosslinkable monomer blocks in a discrete polymer chain are crosslinked via a linkage formed by reaction between the crosslinkable functional groups.

9. A hollow microparticle comprising a hollow portion and a high-density polymer brush layer enclosing the hollow portion, wherein a polymer chain composing the polymer brush layer is a block copolymer of:

i) a crosslinkable monomer block located at inner part of the polymer brush layer, which is represented by the formula:

[Formula 57]

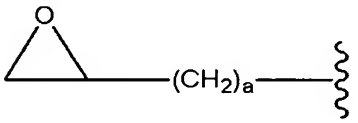


wherein

R_1 is a hydrogen atom or a C_1 to C_6 alkyl group,

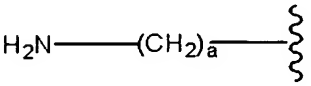
R_3 is a hydrogen atom or a crosslinkable functional group represented by the formula:

[Formula 58]



or

[Formula 59]

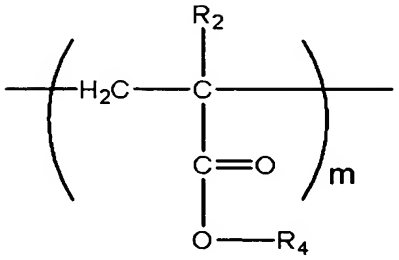


wherein a is an integer of from 1 to 3, and

n is from 10 to 10000; and

ii) a non-crosslinkable monomer block located at outer part of the polymer brush layer, which is represented by the formula:

[Formula 60]



wherein

R_2 is a hydrogen atom or a C_1 to C_6 alkyl group,

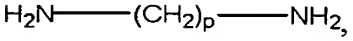
R_4 is a hydrogen atom, a C_1 to C_{12} alkyl group or a phenyl group, and

m is from 10 to 10000; and

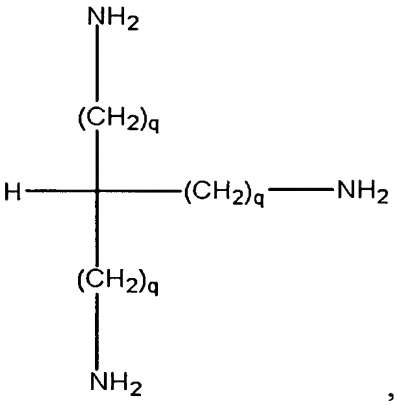
wherein crosslinkable monomer blocks in a polymer chain and the crosslinkable monomer blocks in a discrete polymer chain are crosslinked via a linkage formed by reaction between the crosslinkable functional group and a polyfunctional compound; and

wherein, if R_3 is a hydrogen atom, the polyfunctional compound is represented by a formula selected from the group consisting of:

[Formula 61]

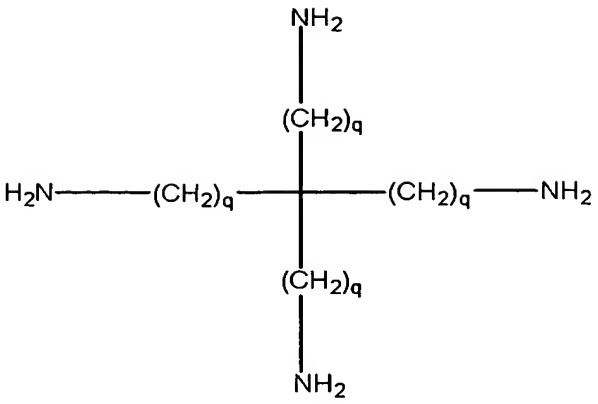


[Formula 62]



and

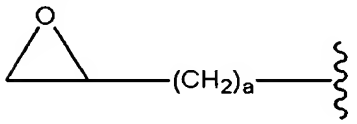
[Formula 63]



wherein p is an integer of from 1 to 6, and q is an integer of from 1 to 3;

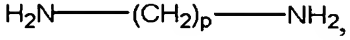
if R_3 is a crosslinkable functional group represented by the formula:

[Formula 64]

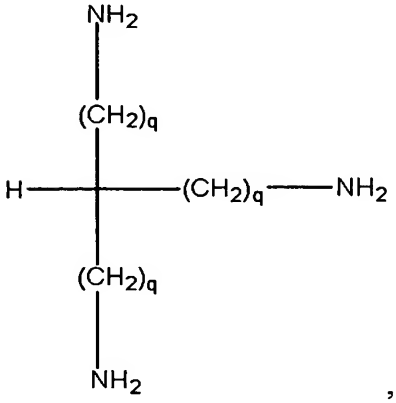


the polyfunctional compound is represented by a formula selected from the group consisting of:

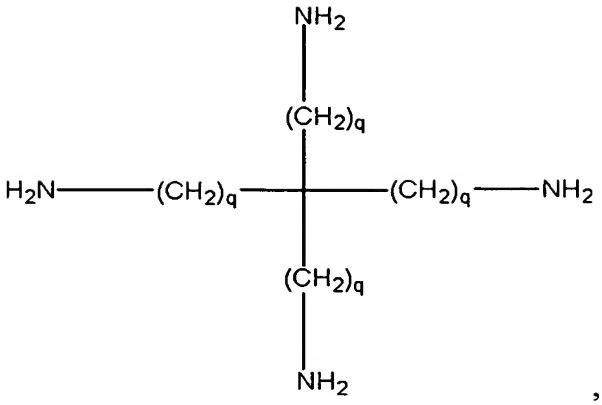
[Formula 65]



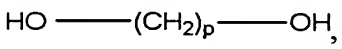
[Formula 66]



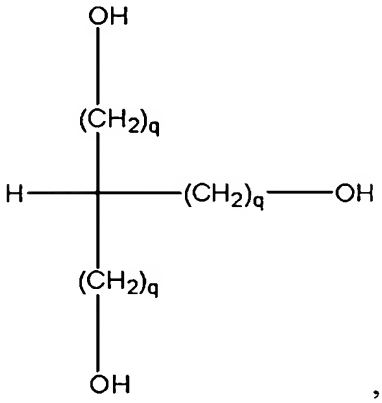
[Formula 67]



[Formula 68]

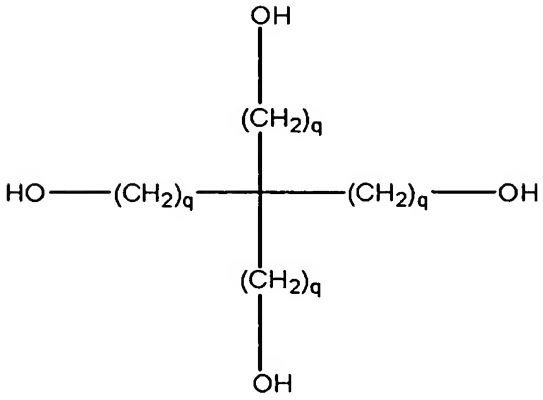


[Formula 69]



and

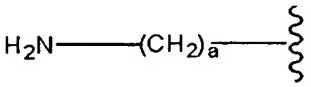
[Formula 70]



wherein p and q are as defined above; or

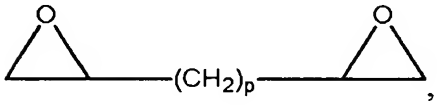
if R_3 is a crosslinkable functional group represented by the formula:

[Formula 71]

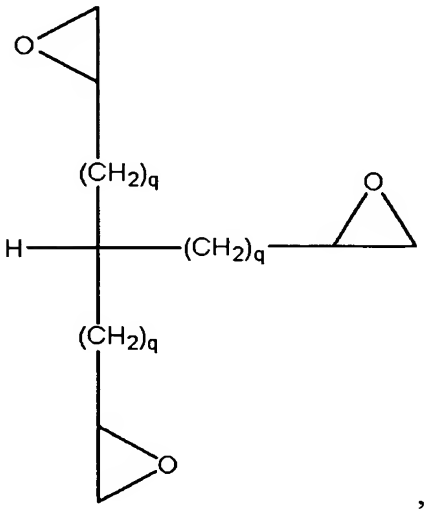


the polyfunctional compound is represented by a formula selected from the group consisting of:

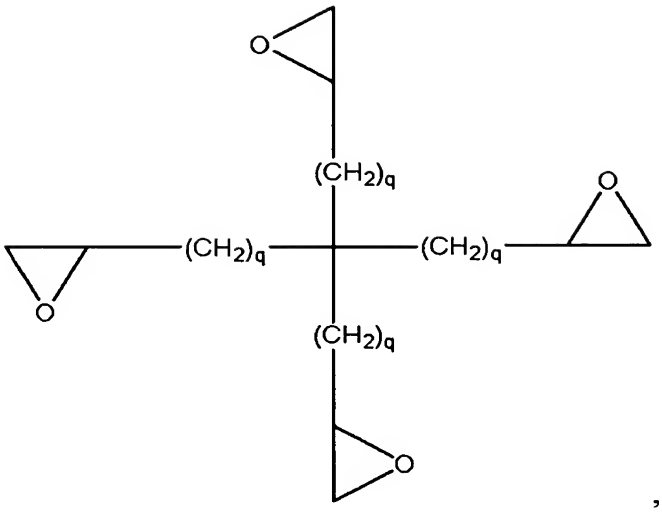
[Formula 72]



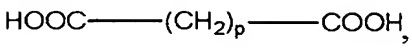
[Formula 73]



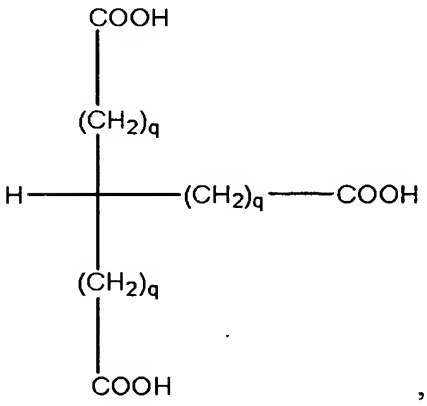
[Formula 74]



[Formula 75]

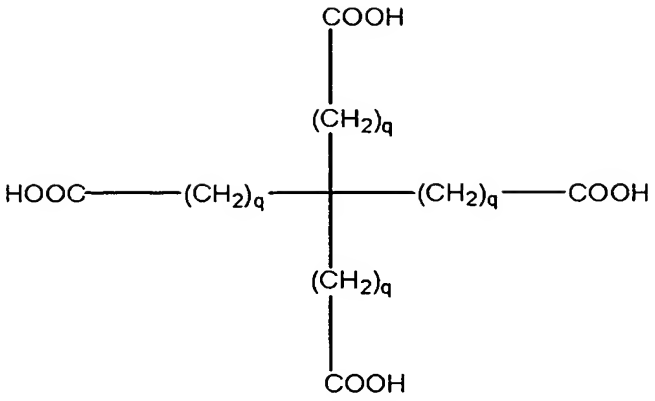


[Formula 76]



and

[Formula 77]



wherein p and q are as defined above.

10. A process for producing a hollow microparticle comprising a hollow portion and a high-density polymer brush layer enclosing the hollow portion, comprising the steps of:

a) attaching a polymerization initiation group to a microparticle surface;

b) bringing into contact a microparticle having the polymerization initiation group on its surface with a crosslinkable monomer under the conditions for living radical polymerization to obtain a composite microparticle in which a high-density polymer brush layer is attached to the microparticle surface;

c) bringing into contact a crosslinkable polymer brush of the composite microparticle with a non-crosslinkable monomer under the conditions for living radical polymerization to obtain a composite microparticle in which a block copolymer is attached to the microparticle surface;

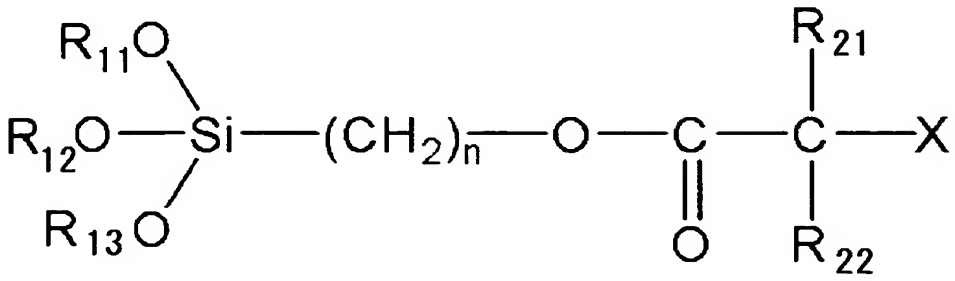
d) subjecting the composite microparticle in which the block copolymer is attached to the microparticle surface to the conditions for crosslinking reaction; and

e) bringing into contact the composite microparticle in which the block copolymer is attached to the microparticle surface with an eluent under such conditions that the microparticle is only eluted with no influence on the block copolymer to elute only the microparticle.

11. The process according to Claim 10, wherein the step a) is carried out by

bringing into contact a compound represented by the formula:

[Formula 78]



wherein

n is an integer of from 3 to 10,

R_{11} to R_{13} independently represent a C_1 to C_3 alkyl,

R_{21} and R_{22} independently represent a methyl group or an ethyl group, and

X represents a halogen atom,

with a microparticle of silica, a metal oxide or a metal sulfide under such conditions that the compound and the microparticle may react.

12. The process according to Claim 11, wherein the crosslinkable monomer is acrylic acid, methacrylic acid or an acrylate or methacrylate having a functional group selected from the group consisting of an epoxyalkylene group, an aminoalkylene group, an oxetanylalkylene group and a cinnamoylalkylene group, and

the non-crosslinkable monomer is selected from the group consisting of an acrylate derivative, a methacrylate derivative, a styrene derivative, vinyl acetate and acrylonitrile.

13. The process according to Claim 10, wherein the step d) is carried out by photo- or heat-treating the composite microparticle in which the block copolymer is attached to the microparticle surface in the presence or absence of an initiator.

14. The process according to Claim 10, wherein the step d) is carried out by adding a polyfunctional compound capable of reacting with a crosslinkable

functional group in the crosslinkable monomer block.

15. The process according to Claim 10, wherein the eluent is an aqueous solution of hydrogen fluoride.